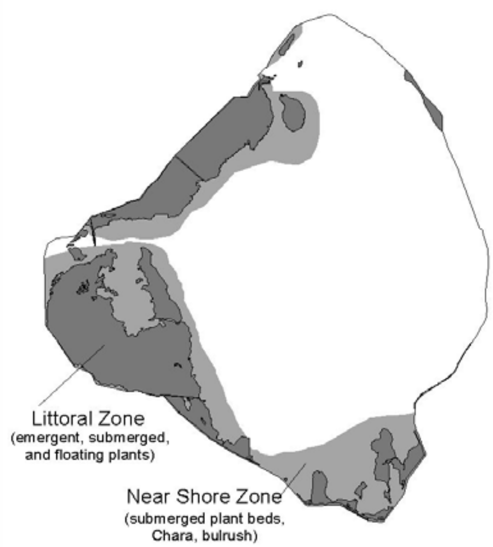
Lake Okeechobee Aquatic Vegetation Monitoring

Aquatic vegetation monitoring for Lake Okeechobee is designed to establish an ecological baseline, and to determine whether modified hydro-pattern and reduced phosphorus inputs projected to occur under regional restoration programs bring about a recovery of native plant communities from their present condition. The program focuses on two major physiographic regions within the lake -- littoral and near-shore (**Figure 1**), and two ecological components -- emergent and submerged vegetation.

The littoral zone emergent vegetation is a diverse mosaic of native and exotic plants covering an area larger than 400 km^2. It provides nesting habitat and food resources for economically important sport fish populations, wading birds, migratory waterfowl, alligator, and federally endangered Everglades snail kites. The structure of the littoral vegetation community largely determines the extent to which it can provide these habitat values. Littoral vegetation structure is influenced both by hydroperiod and phosphorus loading from the lake's eutrophic pelagic region.

Figure 1. Two major physiographic regions of Lake Okeechobee that are included in the aquatic vegetation research and monitoring program. The central pelagic zone is not included in this program because it does not support plants (due to deeper, more turbid water).



Submerged vegetation is a keystone component of the shallow near-shore area that occurs in a 200 km^2 region between the littoral zone proper and the deeper pelagic (open-water) zone of the lake. Submerged vegetation provides habitat for fish and wading birds, and it directly affects water quality by stabilizing sediments and providing a substrate for periphyton (attached algae) that actively removes phosphorus from the water column. At times and locations where submerged vegetation is very abundant, water is clear, and phytoplankton blooms are rare. Submerged vegetation spatial extent and biomass are expected to increase significantly as a result of regional restoration programs.

Monitoring Methods

1. Littoral plant communities

The spatial distribution of native and exotic plants in the lake's littoral zone is being evaluated in an ongoing program by the SFWMD. Emergent vegetation is photographed using high-resolution infrared aerial photography. Major vegetation classes (34 total) are delineated from the photographs using a stereoscope, and maps are developed in ARC/INFO. Extensive ground-truthing is carried out as a part of this process. The most recent mapping efforts have resulted in a classification accuracy of near 90%, which compares favorably with an accuracy of 60% that was associated with earlier maps developed from satellite imagery. At this time, bi-annual mapping is done to quantify the spatial distribution of torpedograss (*Panicum repens*) because this exotic plant is the focus of an ongoing multi-million dollar per year eradication program. Bi-annual mapping is also done for bulrush (*Scirpus californicus*), a dynamic community that occurs along the interface between the pelagic and littoral zones. Mapping of the entire littoral vegetation community, a much more cost and labor intensive effort, is carried out approximately at six-year intervals. There are ongoing efforts by the SFWMD and NOAA to identify potential for use of hyper-spectral remote sensing as a more effective method for mapping the entire littoral zone of this large lake.

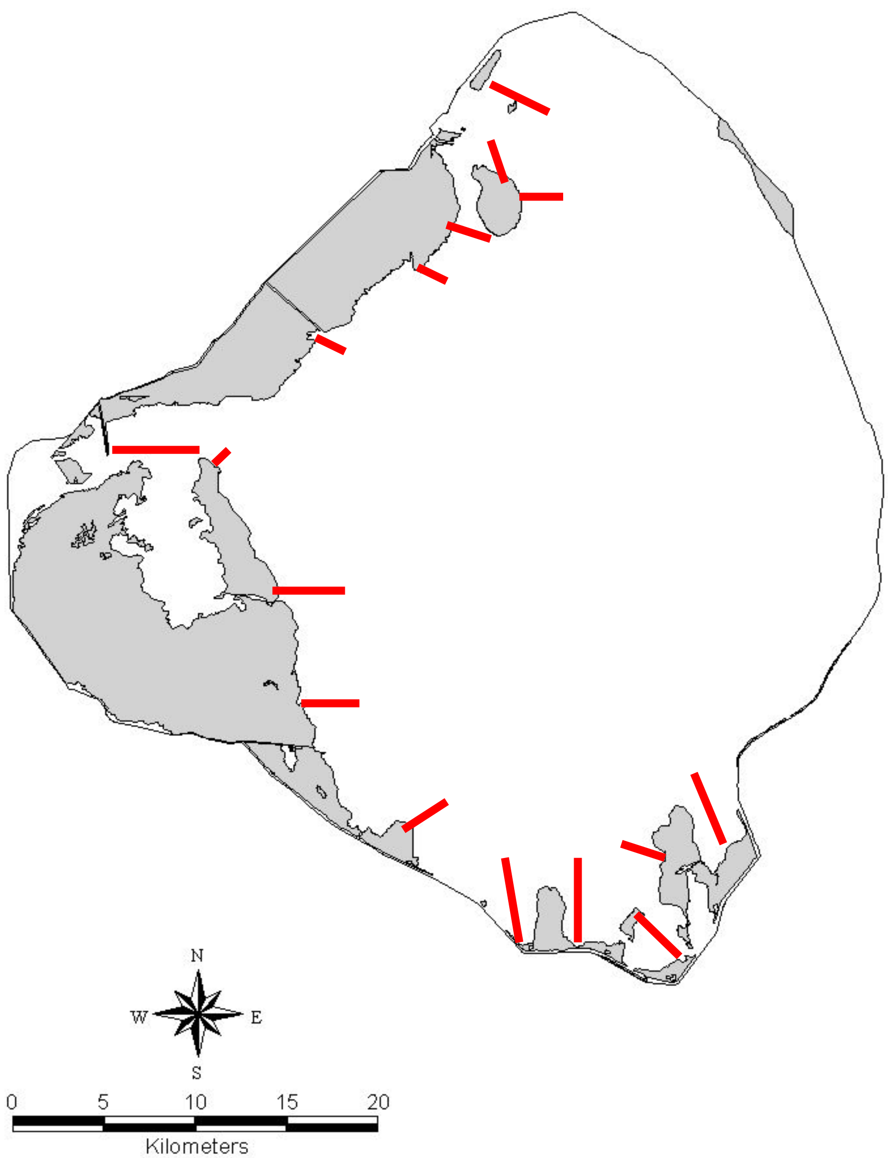
2. Submerged vegetation

Submerged vegetation is monitored at two different spatial/temporal scales by the SFWMD. Both methods rely on in-water sampling (rather than remote sensing) because it often is the case that areas with submerged vegetation have water that is highly colored by dissolved organics or suspended solids. Remote sensing drastically underestimates the spatial extent of submerged vegetation under these conditions and is biased towards higher estimates at times and locations when water clarity is high (e.g., during calm summers with low lake stage).

In order to obtain quantitative estimates of plant species biomass, sampling is done at sites located along 16 transects in areas of the lake that support submerged plants (**Figure 2**). On a quarterly basis (monthly from May to September), triplicate samples are collected at sites along each transect, starting at the shoreline and progressing lake ward until a site is reached with no plants. Plant sampling is done using a tool constructed of two standard garden rakes bolted together at mid-point to create a tong-like device. The degree of opening is constrained by placing a chain between the two handles so three replicate samplings with the device remove ~1 m^2 of bottom cover. The harvested material is sorted by species, stripped of epiphyton, and analyzed for dry mass. At the same time that plant sampling is done, measurements are made of total depth, Secchi depth, and sediment type. Data from the SFWMD water quality monitoring program, which includes stations in the vicinity of all SAV sampling sites, is used to identify other water quality conditions, including underwater irradiance and temperature profiles, color, chlorophyll *a*, total and soluble phosphorus, total and soluble nitrogen, and total and non-volatile suspended solids. The water chemistry data is important to understanding the light-attenuating properties of the water and explaining observed trends or patterns in submerged vegetation.

The spatial extent of submerged vegetation is determined by an intensive sampling program (**Figure 3**) that is carried out every August-September, the period of peak biomass of this community. Rather than sampling random locations, the entire near-shore shelf area is sampled at a relatively fine spatial scale. A GIS coverage of the lake surface is overlaid onto a rectangular grid of 1,000 x 1,000 m cells in ARC/INFO. A GIS coverage of the littoral zone is laid onto the map, and common cells are clipped from the final coverage, as is the deeper central pelagic region. This results in a near-shore grid of approximately 500 sampling sites. Coordinates for the grid cell center-points are loaded into two Trimble Pathfinder GPS units (differentially corrected) for use in navigating to the sampling sites. A simple program is set up in each data logger so that users can enter information regarding water depth, Secchi depth, sediment type, presence vs. absence of vegetation taxa, and a qualitative estimate of overall plant biomass (sparse, moderate, dense).

Figure 2. Map of Lake Okeechobee, showing the location of 16 transects for quarterly evaluation of submerged aquatic vegetation biomass, taxonomic structure, and water transparency. Plants are sampled at sites along each transect, starting at the shoreline and progressing lake ward until a site is reached where there are no plants.



Sampling starts in late August and is complete by mid-September. Sample runs begin near the shoreline and proceed lake ward along row of cells until two consecutive cells are encountered with no SAV. The boat operator navigates to the sites by GPS, where water depth is measured with a calibrated plastic rod and Secchi depth is measured with a 20-cm black and white disk. Plant sampling is as described above. Plants are placed into a plastic tray and sorted by species, and the information described above is entered into a data logger. Sediment type is determined by inspection of material brought up in the rakes or by observation from the boat where water transparency is good. Sampling with this method is possible up to a maximal depth of approximately 3 m. Field data are downloaded from the GPS logger into ARC/INFO, where maps are developed for each of the measured attributes and spatial extents are calculated in hectares. It is assumed that data collected at the center-point of a grid cell represents that of the entire cell. While this may introduce error into the results, it is a necessary assumption given the large spatial scale of sampling.

Figure 3. Map of Lake Okeechobee, showing the 1,000 x 1,000 m sampling grid for yearly evaluation of SAV spatial extent. This map shows results of the 2001 survey. Maps of this type are produced for each dominant plant species.